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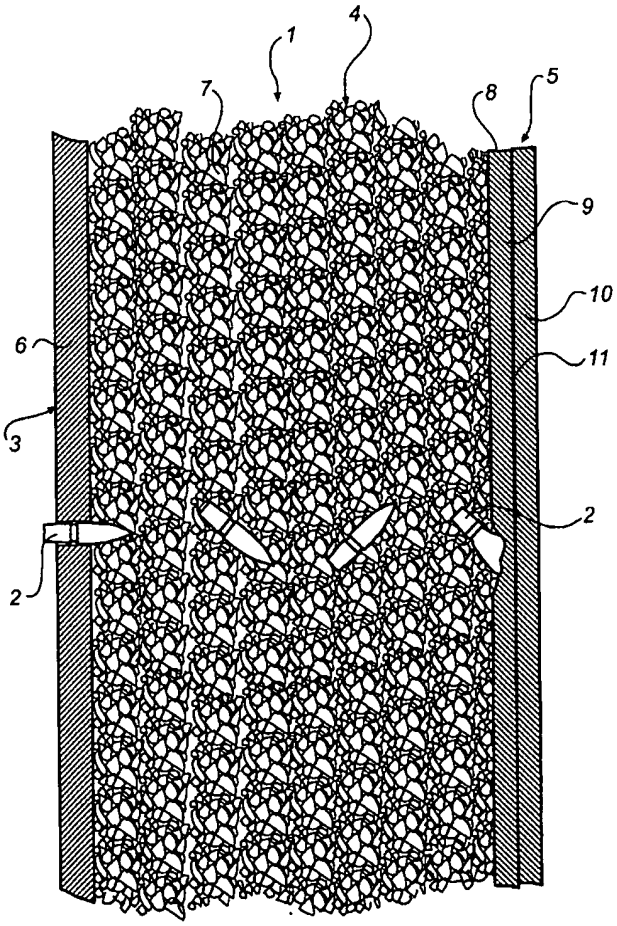
(54) Title: BALLISTIC PROTECTION



(57) Abstract: A ballistic shield for protection against projectiles (2) fired from small arms is designed as a wall structure comprising an outer element (3) allowing passage-through of the projectile (2) without the latter being deformed and/or decelerated to any substantial degree, an intermediate element (4), which is arranged to force the projectile (2) to tip and to cause it to decelerate heavily, and an inner element (5), which is struck by and ultimately arrests the projectile. The outer element (3) is configured as a thin plate (6) of a soft material, allowing unobstructed passage-through of the projectile (2) while the intermediate element (4) is formed by a layer (7) of a decelerating material designed to cause the projectile to tip and be heavily decelerated, and the inner element (5) is configured as a thin plate (8) of a material absorbing the remaining kinetic energy of the projectile.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

BALLISTIC PROTECTION

TECHNICAL FIELD

The present invention relates to a ballistic shield for protection against projectiles fired from small arms. A shield of this kind is used as mobile shelters, mobile action information centres, etcetera, for military purposes, but also as bullet-proof containers, flexible protective partitions and bullet-proof fittings in banks and so on. It could likewise be used as protective flooring in e.g. transportation aeroplanes and as protection in certain types of vehicles.

TECHNICAL BACKGROUND

The following basic methods of realising ballistic shields for protection against ammunition/projectiles from small arms are those most commonly used today. The following description relates to stationary, semi-stationary and mobile shields, although the principles apply also to e.g. body-protection shields.

Protective method	Protection principle	Advantages	Disadvantages
1. Thin shields: Hard plates, e.g. armour plate.	Protect by high resist-ance against punching.	Effective against soft projectiles. Low volume.	High weight for protection against hard-core projectiles, e.g. armour-piercing ammunition.
1. Thin shields: Fibre composites.	Protect by combination of strength and high break elongation.	Effective against soft projectiles. Light-weight.	Poor protection against hard-core projectiles. Ef-ficient protec-tion requires expensive fibre materials

1. Thin shields: Ceramics	Protect through very high strength and hardness	Effective against hard-core projectiles	Brittle, requires combination with e.g. fibre compo-sites for practi-cal handling. Very expensive.
2. Thick shields: Sand or simi-lar materials	Protect through decelerating of projectile	Inexpensive	Heavy and bulky. Slow mounting.

None of these protection methods offers satisfactory protection also against fully-jacketed projectiles in combination with satisfactory handling, reasonable weight, and a competitive price. This is true particularly as regards projectiles having a hard core, i.e. armour-piercing ammunition. In order to make it possible to construct an efficient ballistic shield possessing these properties, knowledge of the characteristics and the behaviour of the projectiles from which the shield is to serve as protection is a prerequisite for the design of an optimum shield structure.

In the thin shields, the projectile is decelerated very rapidly, involving considerable energy-dissipation over a brief period. The shields must be able to be effective against the projectiles while the latter are at their most efficient, i.e. when they are moving at a high speed and with their point directed at the shield. One consequence thus is that shields against hard-core projectiles need to be thicker and of high-strength type.

The thick shields operate by causing slower deceleration, and the deceleration effect mainly depends on the mass of the projectile. Depending on the density and the properties of the shield as well as on the structure of the projectile, the latter will be decelerated in different ways. Semi-jacketed ammunition (hunting ammunition) dissipates its kinetic energy by mushrooming of the projectile point, i.e. the projectile immediately becomes considerably wider. The deceleration

of the projectile thereafter is rapid, which is the very purpose of the structure.

Fully-jacketed ammunition (military ammunition and sport-shooting ammunition) tips after having traversed a predetermined distance once the projectile has become unstable. This is an established phenomenon known from so called humanity research on ammunition, as will be explained further on in the description.

Fully-jacketed ammunition, and particularly hard-core projectiles, constitutes the most serious threat to ballistic shields on account of the higher strength of such projectiles.

OBJECT OF THE INVENTION

The main object of the present invention is to provide a ballistic shield that is a combination of a retarding shield and a shield that is effective on account of its high strength and high degree of break elongation. This shield thus combines the properties of both kinds of shields, thereby producing substantial synergy effects while exploiting the aspects of strength of the two shields and eliminating their weaknesses.

Another object of the invention is to provide a ballistic shield, which owing to its comparatively small mass is easy to move and which is inexpensive and simple to manufacture.

Yet another object of the invention is to provide a ballistic shield, which is shock-proof and sturdy and which is able to withstand the effects of non-jacketed, semi-jacketed and fully-jacketed projectiles from small arms as also those of tracer bullets and automatic fire.

An additional object of the invention is to provide a ballistic shield, which is comparatively environmentally friendly, which at least partly may consist of recycled materials, and which in itself is recyclable.

Finally, it is an object of the invention to provide a ballistic shield, which may be adapted to and designed to clients' requirements.

SUMMARY OF THE INVENTION

These and other object of the invention are efficiently achieved by designing the ballistic shield as a wall structure having at least one outer element allowing passage-through of the projectile without being deformed and/or decelerated to any substantial degree, at least one intermediate element, which is arranged to force the projectile to tip and to cause it to decelerate heavily, and at least one inner element, which is struck by and ultimately arrests the projectile.

The outer element preferably is configured as a thin and essentially flat plate of a comparatively soft material, allowing essentially unobstructed passage-through of the projectile while the intermediate element preferably is formed by a layer of a decelerating material designed to cause the projectile to tip and be heavily decelerated or slowed down, while the inner element preferably is configured as a comparatively thin plate of a material absorbing the remaining kinetic energy of the projectile.

The basic principle of the invention thus is to produce deceleration in a projectile-decelerating shield by means of the above-described combination of shields, such that the projectile is caused to tip or tumble, and ultimate arrest of the projectile in a thin shield. The fact that the projectile tips or turns over means that the latter shield stops the projectile, when said projectile is ineffective from a penetration point of view. Consequently, the thin shield is not exposed to stress of the same magnitude as would have been the case, had it been used on its own, and for this reason it could be made thinner and be manufactured from cheap materials. The decelerating material may be chosen from materials

that are as lightweight and as durable as possible but yet possess the desired properties.

With knowledge of the principles of behaviour of the projectiles in the various materials and based on tests carried out with different combinations of shields as well as with different materials in different thicknesses and with respect to projectiles of different types, it becomes possible to produce an optimum ballistic shield.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be described in more detail in the following with reference to the accompanying drawings illustrating a presently preferred embodiment of the invention. In the drawings:

Fig 1 is a perspective view of a ballistic shield in accordance with the invention in the form of a mobile shelter as seen obliquely from the front,

Fig 2 is a longitudinal sectional view showing a part of the shelter of Fig 1, and

Fig 3 is a schematic sequence of pictures numbered 1-10 and showing the principle of behaviour of a projectile as it is being decelerated when passing through a denser medium.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

The primary function of the ballistic shield in accordance with the invention as shown in Figs 1 and 2 and generally designated by numeral 1 is to serve as perfectly satisfactory protection against small-calibre projectiles 2 of various types used in small arms, not shown, such as pistols, guns, automatic weapons and so on. In the drawings, the shield is configured as a protective upright shelter for protection of soldiers, not shown. As previously mentioned, the shield 1 could be designed in a variety of different ways as regards shapes and sizes without departure from the fundamental structure of the shield against projectiles 2.

The ballistic shield 1 is designed as a wall structure the principal parts of which are an outer element 3, an intermediate element 4 and an inner element 5.

The outer element 3 allows passage-through of the projectile 2 without being deformed or decelerated to any significant degree, and in the shown embodiment the element is configured as a thin and essentially flat plate 6 of a comparatively soft material allowing the essentially unobstructed passage-through of the projectile 2. The plate 6 could be manufactured from practically any material that is adequate for the intended purpose, but preferably it is manufactured from e.g. thin plating (of for instance aluminium), wood (such as plywood), or most preferably from plastics or the like. Practical tests have shown that a plate 6 of glass-fibre-reinforced ester plastics having a thickness of approximately 2-5 mm, most preferably about 3 mm, meet the requirements on such plates.

The purpose of the intermediate element 4 is to cause the projectile 2, after the latter having pierced the outer element 3, to tip or turn over and to be decelerated or slowed down considerably, and it consists of a layer 7 of a decelerating material. This material comprises a granulate of a suitable, resilient material, such as polymer, rubber, silicone rubber and so on. The rubber may be a waste/recycle product recovered from e.g. vehicle tyres. In the embodiment shown and described herein the granulate has a particle size of about 2-5 mm. However, the particle size may vary, depending on the type of the granulate material, the thickness of the layer 7 and the type of projectile 2, but practical tests have shown that the particle size should be somewhere in the range of 1-6 mm. The same principle of reasoning is applicable to the thickness of the layer 7; in the shown embodiment the layer thickness amounts to 80-200 mm but it could vary between about 50 and 300 mm.

The following may be said with respect to the behaviour of the projectile 2 as it passes through the layer of the intermediate element 4, with reference to the sequence of pictures shown in Fig 3, and also to Fig 2. When the projectile 2 strikes the granulate layer 7, which is a medium that is denser than the surrounding atmospheric air, the conditions of forces around the projectile are changed considerably. One of the fundamental reasons for the tipping of the projectile 2 is that the centre of pressure is displaced forwarding, to the point of the projectile, and that the lever of the tipping force therefore becomes longer. The reason therefor is that the granulate material in layer 7 is forced away from the projectile and is in contact only with the projectile point, which in turn depends on the changed conditions of flow in layer 7 compared with those of the atmospheric air. Another fundamental reason for the tipping phenomenon is that the higher density of the layer 7 produces a larger tipping moment, the increase being directly proportional to the higher density.

The groove 12, see Fig 3, that forms behind the projectile 2 as the latter passes through the layer 7 of granulate is rapidly filled up by the surrounding granulate. The granulate layer thus rapidly becomes "intact" again and ready to cause a fresh projectile or several fresh projectiles to tip and be decelerated, even if these projectiles follow the same or essentially the same path as the preceding one/ones.

The inner element 5 forming another one of the main components of the ballistic shield 1 in accordance with the invention preferably is configured as a comparatively thin plate 8, see Fig 2, of a material that absorbs the remaining kinetic energy of the projectile and ultimately stops the latter. The plate 8 preferably is made from reinforced plastics, and tests show that an ester plastic that is reinforced with glass fibre and/or aramide fibres of para type (Kevlar®) are well suited for the purpose.

The thickness of the plate 8 preferably is in the range of about 15-25 mm but for the same reasons as mentioned previously it may vary between about 10 and about 30 mm.

In order to increase the kinetic-energy absorbing and arresting properties of the plate 8 it may be suitable when manufacturing the plate of glass-fibre and/or aramide-fibre reinforced plastics to make sure that the plastic material is not completely saturated through with the binding agent. This prevents the fibres from becoming completely embedded in the plastic material but instead retain some movability, with consequential increase of the ability of the fibres to absorb the remaining kinetic energy of the projectile 2.

An additional or supplementary way of increasing the ability of the plate to absorb the remaining kinetic energy of the projectile and to arrest the latter is to manufacture the plate 8 forming the inner element 5 as a laminate comprising at least two panels 9 and 10, see Fig 2. Sandwiched between the two panels 9, 10 there is an intermediate layer 11 consisting of a suitable resilient and adhesive material. Among one of several tested materials a layer of silicone rubber having a thickness of about 1-5 mm, has proved to meet the necessary requirements. In this case, the panels 9, 10 should have a thickness in the range of between 5 and 10 mm.

The invention should not be regarded as limited to the embodiment as shown and described herein but could be modified in a variety of ways within the scope of protection defined in the appended claims. For instance, the thickness and other dimensions of the elements 3, 4 and 5 forming part of the ballistic shield 1 as also the choice of material therefor could be varied according to need and demand, and the number of plates 6, 8 and layers 7 of each element could likewise be varied.

CLAIMS

1. A ballistic shield for protection against projectiles (2) fired from small arms, c h a r a c t e r i s e d by a wall structure comprising at least one outer element (3) allowing passage-through of the projectile (2) without the latter being deformed and/or decelerated to any substantial degree, at least one intermediate element (4), which is arranged to force the projectile to tip and to cause it to decelerate heavily, and at least one inner element (5), which is struck by and ultimately arrests the projectile.

2. A ballistic shield as claimed in claim 1, wherein the outer element (3) is configured as a thin and essentially flat plate (6) of a comparatively soft material, allowing essentially unobstructed passage-through of the projectile (2).

3. A ballistic shield as claimed in claim 2, wherein the plate (6) is made from plywood, plastics or the like, preferably from glass-fibre-reinforced ester plastics, and has a thickness of about 2-5 mm, preferably about 3 mm.

4. A ballistic shield as claimed in any one of the preceding claims, wherein the intermediate element (4), which is positioned between the outer and inner elements (3, 5), is formed by a layer (7) of a decelerating material designed to cause the projectile (2) to tip and be heavily decelerated.

5. A ballistic shield as claimed in claim 4, wherein the layer (7) of decelerating material consists of a granulate, preferably of polymer and/or rubber, having a particle size of about 1-6 mm, preferably about 2-5 mm, and a thickness of about 50-300 mm, preferably about 80-200 mm, depending on the type of projectile (2) that is to be stopped.

6. A ballistic shield as claimed in any one of the preceding claims, wherein the inner element (5) is configured as a comparatively thin plate (8) of a

material absorbing the remaining kinetic energy of the projectile (2).

7. A ballistic shield as claimed in claim 6, wherein the plate (8) is manufactured from reinforced plastics, preferably an ester plastic reinforced with glass fibre and/or aramide fibres of preferably para type, and has a thickness of about 10-30 mm, preferably about 15-25 mm.

8. A ballistic shield as claimed in claim 7, wherein the glass-fibre and/or aramide-fibre reinforced plastics is not saturated completely through in order to increase the strength of the fibres and consequently their ability to absorb the remaining kinetic energy of the projectile (2).

9. A ballistic shield as claimed in any one of claims 7 or 8, wherein the plate (8) is composed of a laminate comprising at least two panels (9, 10) between which is sandwiched an intermediate layer (11) of a resilient and adhesive material, such as silicone rubber, to further increase the ability of the plate (8) to absorb kinetic energy.

10. A ballistic shield as claimed in claim 9, wherein each panel (9, 10) has a thickness of about 5-10 mm and each material layer (11) has a thickness of about 1-5 mm.

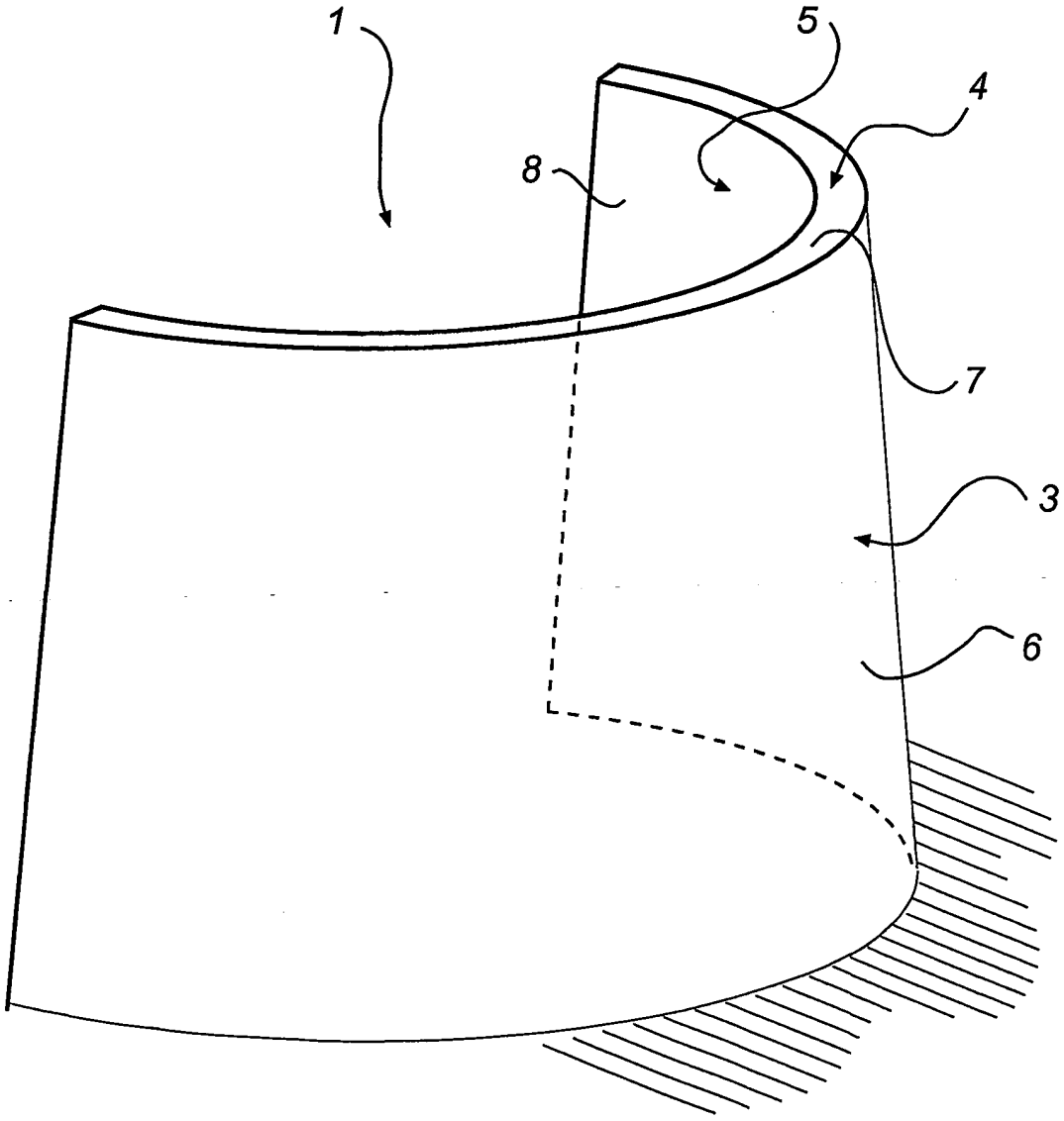

Fig. 1

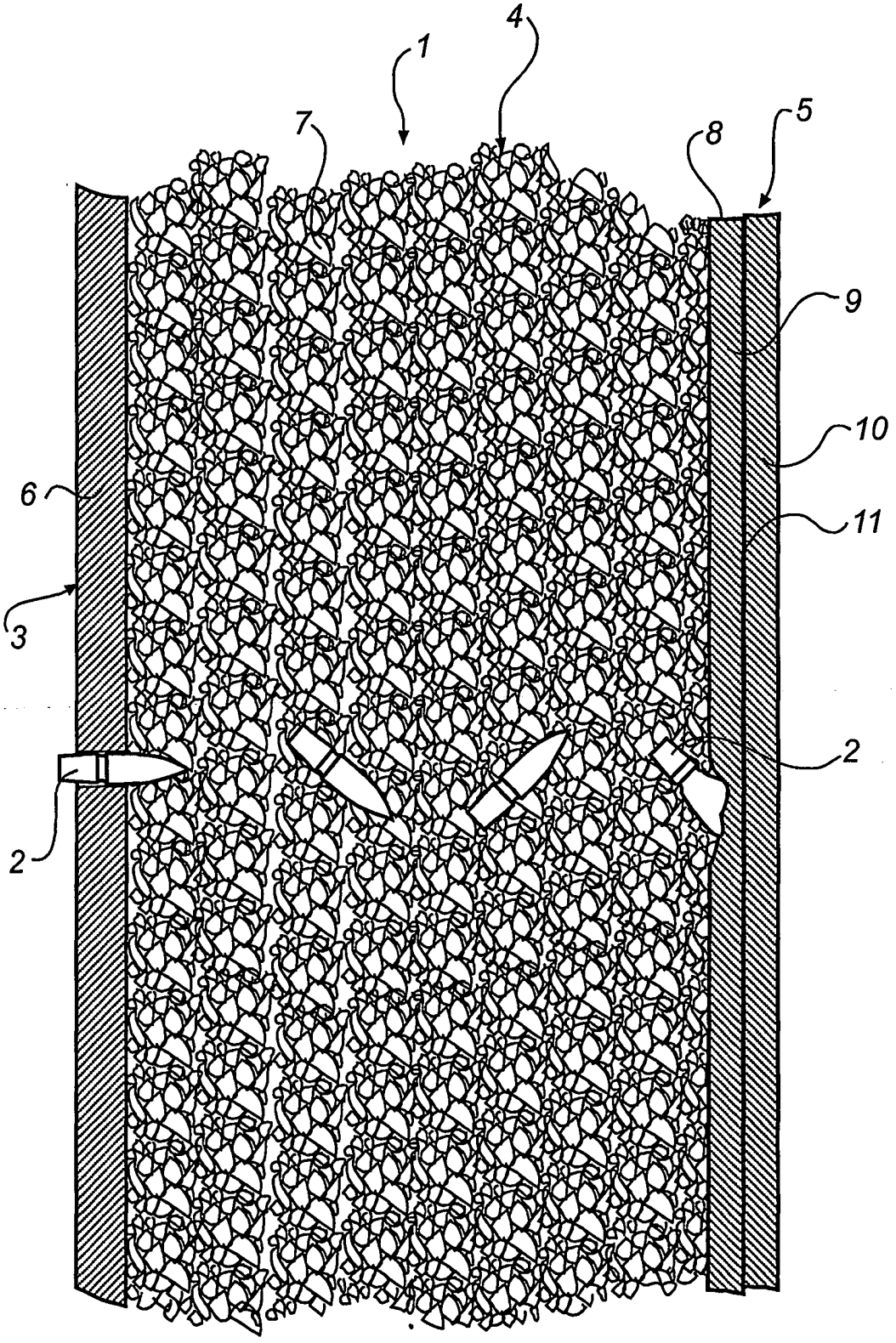

Fig. 2

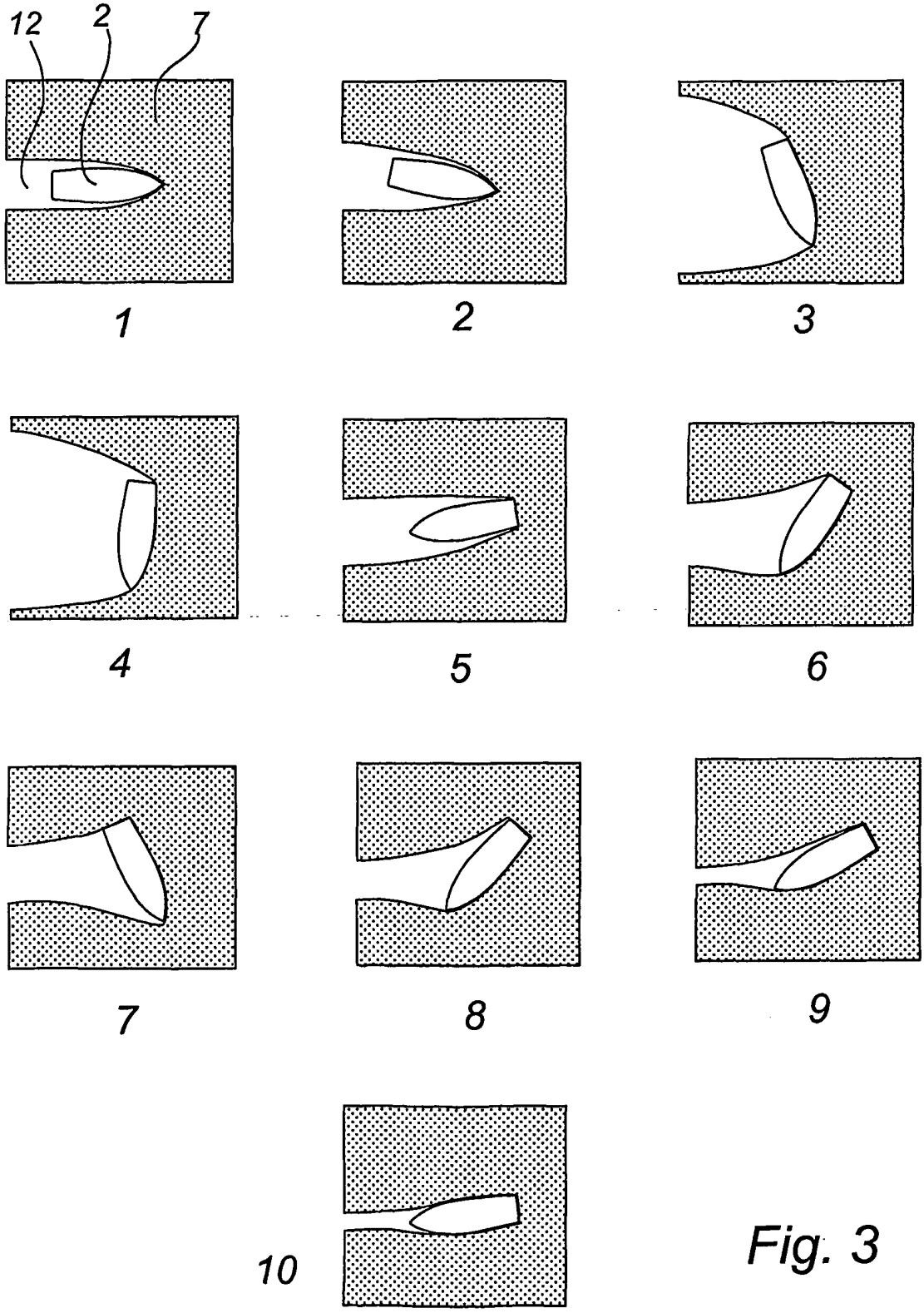

Fig. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 01/00890

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: F41H 5/04
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: F16H, F41J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

E-DOC, EPI, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3431818 A (H.A. KING), 11 March 1969 (11.03.69)	1-4,6-7,9-10
Y		5
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Y	FR 2649743 A1 (CAMPENON BERNARD), 18 January 1991 (18.01.91)	5
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A	US 5866839 A (OHAYON), 2 February 1999 (02.02.99)	1-10
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A	US 5723807 A (KUHN, II), 3 March 1998 (03.03.98)	1-10
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☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
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INTERNATIONAL SEARCH REPORT

Information on patent family members

02/07/01

International application No.
PCT/SE 01/00890

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 3431818 A	11/03/69	DE 1578324 A	02/01/70
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